TEXAS AGRICULTURAL EXPERIMENT STATION

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College Station, Texas

BULLETIN NO. 657 AUGUST 1944

INFLUENCE OF AGE, TYPE AND FERTILITY IN RAMBOUILLET EWES ON FINENESS OF FIBER, FLEECE WEIGHT, STAPLE LENGTH, AND BODY WEIGHT

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E03-844-8500-L180

Fig. 1. Registered Rambouillet rams bred by Ranch Experiment Station (Substation No. 14), representing both B and C types used in this study.

The study reported in this bulletin relates to the influence of age, fertility, and body type in Rambouillet ewes on fleece weight, length of staple, fineness of fiber and body weight. Heaviest scoured fleeces were produced during the third age year, however when considered on either an unscoured or scoured basis the differences in production of fleeces during the third and fourth age years were not significant. There was however a gradual decline in fleece weight after the fourth age year. Significant differences of 0.53 and 1.18 pounds in clean weight and grease weight respectively were observed between the four and eight year old ewes.

Staple length was greatest during the first age year, all adjusted to 365 days growth. There were no significant differences in staple length during the second, third and fourth age years. By the sixth age year however, staple length had decreased approximately 0.3 inch and by the eighth age year 0.44 inch, or 18 per cent. Fertile ewes, or those producing lambs during the year, produced wool that averaged 0.08 inch shorter and averaged 0.27 pound less scoured wool than ewes that did not lamb during the year. The diameter of fiber, or fineness of the wool fiber, produced during the first age year averaged slightly but significantly finer than in later age years. After the first year diameter changed so slightly as to be of no practical importance.

Body type exerted considerable influence on various characteristics of the wool fiber. The C type, or relatively smooth bodied ewes, produced fleeces that had significantly greater length of staple, finer and more uniform fibers than B type ewes. Accordingly the fleeces from the C type ewes had a higher commercial value.

There were no significant differences in scoured fleece weights produced by the B and C type ewes. However, on an unscoured basis, the fleeces produced by B type ewes averaged approximately one pound heavier than those produced by C type ewes. Shrinkage of the fleeces from the B type ewes averaged 62.9 per cent as compared with 59.4 per cent shrinkage from the C type ewes.

There were no significant differences in body weights between the plain bodied and the wrinkly or folded types used in these studies.

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INFLUENCE OF AGE, TYPE AND FERTILITY IN RAMBOUILLET EWES ON FINENESS OF FIBER, FLEECE WEIGHT, STAPLE LENGTH, AND BODY WEIGHT

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History has not recorded accurately the use of wool as an article of apparel, however its use is believed to have been co-extensive with the history of man. Wool for a long period of time has been considered a complete or perfect fiber, consequently very little research aimed toward its improvement was undertaken until comparatively recent years. The wide development of competing fibers, the result of highly technical and specialized research, in recent years however has focused attention on the need of expanded study of all of the standard fabrics, and wool is beginning to receive the attention it deserves. A large percentage of the earth's untillable surface has throughout history been devoted to the production of animal fibers and meat, and such usages of those areas should in the interest of the security of our pastoral industry be continued.

During the early years of the range sheep industry in Texas, wool production was the principal objective of the sheep owners, and since the general belief at the time was that Merinos and Rambouillets carrying a relatively heavy development of skin folds or wrinkles produced heavier fleeces, the general tendency was in the direction of medium heavy to heavy skin folded types. However, as time passed the demand for mutton and lamb increased and range breeders found to their disappointment that the sheep carrying heavy skin folds and body wrinkles were discriminated against by feeder buyers.

The Merino and Rambouillet range breeders were immediately placed in a predicament. They wanted to produce a type of lamb that would not be discriminated against by feeders yet at the same time they desired not to sacrifice too much fleece weight and quality in their shift to a smoother bodied type.

Research workers at this station, realizing the scarcity of definite information on the entire subject relating to comparative weights, lengths, and finenesses of wool produced by relatively smooth bodied Rambouillet sheep as compared to those carrying various degrees of skin folds, began an inheritance study in 1918. One of the principal objectives was to gain some further definite information on diameter of wool fiber and fiber length in relationship to age of animal. A still further objective was the possi-

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bility of the development of a relatively smooth bodied Rambouillet possessing the desired fleece characteristics which could be maintained without having to resort to the use of sires or dams of heavy skin fold development for the purpose of maintaining unscoured fleece weight.

The results reported in this bulletin relate specifically to the influence of age, type and fertility of Rambouillet ewes on (a) fleece weight and shrinkage, (b) staple length, (c) fineness of wool fiber, and (d) body weight.

PROCEDURE

The records used in this study were taken from all B and C type, registered Rambouillet ewes maintained at the Ranch Experiment Station located in Edwards and Sutton counties near Sonora, for the period 1923-1940 (18 years) inclusive.

The sheep were grazed on a range affording a mixed grassland type of vegetation consisting largely of curly mesquite grass and Buffalo grass, winter grasses and weedy plants and characterized by numerous small thickets of live oak, shin oak, and miscellaneous brush. Light-shearing, open-fleeced and otherwise undesirable animals were removed from the

Fig. 2. B type (medium) Rambouillet Ram.

experiment from time to time, the usual procedure being to cull them at the yearling age.

The annual rainfall during the period 1923-1940 inclusive averaged 23.90 inches although the variation was pronounced during certain years. In 1923 the rainfall was 31.65 inches and in 1933 it dropped to 13 inches, in 1934 to 12 inches, then in 1935 it reached a high of 41.50 inches.

The sires used in the breeding flock were registered and perhaps slightly better than the average for the area. The ewe flock was predominantly C type, although a number of B type ewes believed adequate to provide information essential for comparison were maintained for research purposes.

Definition of Terms Used

When this study began there was no recognized standard of perfection for the breed. The B type was defined as "a comparatively heavy folded Rambouillet carrying several large neck folds one or more of which extended prominently over the top of the neck, and further showing one or more skin folds back of the elbow joint, on the sides, at the tailhead, and on the thighs." The C type was defined "free or comparatively free from skin folds upon any portion of the body." Animals with one or more apron folds none of which extended prominently over the top of the neck, and which were free from folds on other parts of the body were designated as C type animals.

Fertility

The designations refer to ewes that dropped lambs or did not drop lambs respectively for the season corresponding to the given age. No separation has been made as to whether the ewes nursed lambs during the previous season, though none of the ewes used in this study were chronically sterile over a prolonged period.

Flock Management

The ewes were, except during the breeding and early lambing season, grazed together on the same range. The natural vegetation varied somewhat from season to season in accordance with rainfall. In some growing seasons the range vegetation was abundant and succulent while in others the vegetation was so scarce that the ewes were definitely on a level of sub-optimal nutrition. A supplement of cottonseed cake was usually fed to all registered ewes during short periods before lambing started. Those which lambed continued to receive supplementary feeds consisting of cottonseed cake, alfalfa hay, or sorghum fodder or silage for a period of several weeks after lambing. Since nutrition is known to exert a marked influence on fleece weight it is considered essential to provide sufficient supplementary feed to adequately nourish the breeding flocks in the area during a portion of the winter season.

The stud rams used during the course of this study were handled in a manner similar to the ewes although in some instances lambs considered

particularly promising as studs were fed concentrates and hay in dry lot following weaning. Ewes remaining in the flock after the most undesirable individuals had been culled were bred to lamb at two years old. Rigid selection was not practiced since it was believed that such a procedure would react unfavorably on the investigations. Several of the best ram lambs were retained in the flock and developed for prospective stud purposes while at the same time a relatively large number was disposed of as range rams. For the most part, in accordance with customs in the area, the registered rams were disposed of in the fleece, hence it was not practical to obtain production records of the representative yearling sale rams.

Beginning in the late twenties, bitterweed *(Actinea odorata)*, a plant which is poisonous to sheep, encroached heavily on the range pastures of the Ranch Experiment Station, and as in other flocks grazing on similar infested ranges in the area, the production of the flock under study has been unfavorably influenced from the standpoints of body weight and production of wool during the period 1928-1940. Measures for the control of internal parasites did not become necessary until 1925, after which time systematic treatment for the common stomach worm, *(Haemonchus contortus)* was generally necessary.

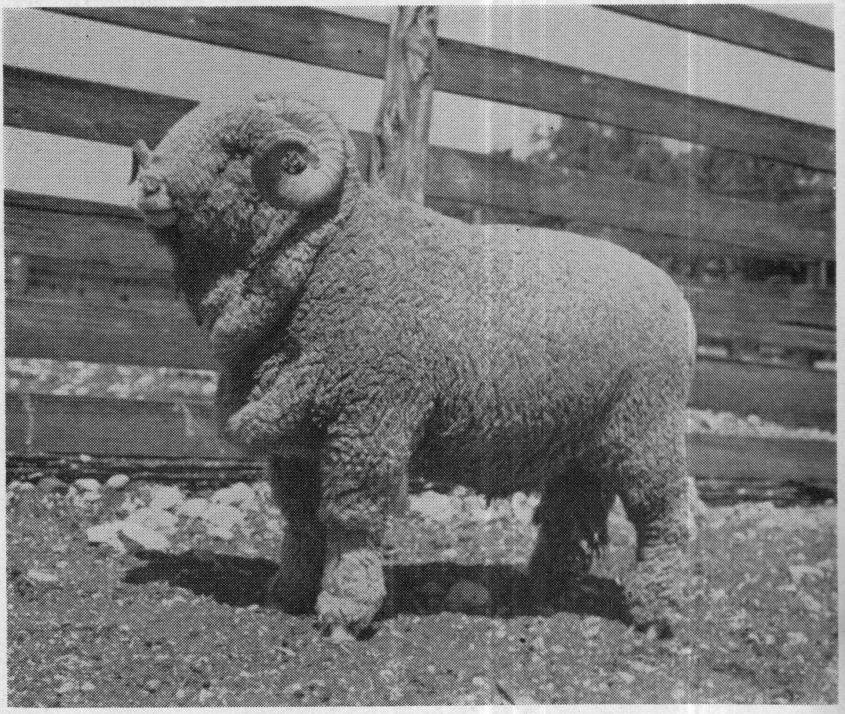

Fig. 3. C type (medium) Rambouillet Ram.

Breeding System

As it was desired to produce an intermediate type, there was a slight deviation from random matings with reference to type. A significant negative correlation (–.123) between sire and dam was found. This negative correlation shows that there were slightly more matings of unlike types than would have occurred by random matings.

Methods of Sampling

All wool samples were taken from three parts of the body, i. e., shoulder, side and thigh, immediately preceding the regular spring shearing. The shoulder samples were consistently taken from a point approximately 3 inches back of the shoulder joint, the side samples midway between the shoulder and hip bone or at a point approximately over the tips of the last two ribs, and the thigh samples at approximately 3 inches below the hip joint. In certain instances with relatively heavy folded B type animals it was necessary to deviate from the plan slightly so as to avoid taking wool samples from prominent skin folds.

At the time of obtaining the wool samples for diameter determinations they were properly identified and forwarded to the Wool Research Laboratory at College Station for measurement.

Method of Measuring Staple Length

Length of staple was measured and recorded to the nearest one-eighth inch immediately before shearing at the same time the wool samples were taken for diameter measurements. These length measurements were determined on an unstretched fiber basis. Hultz (12) has reported that staple length averaged 66.54 per cent of the stretched fiber lengths. A thin measuring rule was inserted gently to the skin at several points on the respective body regions sampled (shoulder, side, and thigh) and an average of three readings from each of these regions was recorded. Owing to the even structure of the fiber tips of the Rambouillets used in this study the length of staple measurement is believed to be adequate for the purpose. All staple length measurements were adjusted to the equivalent of 365 days growth.

Method of Measuring Diameter of Fiber

The Brown and Sharpe micrometer caliper graduated to one-ten thousandth of an inch and which has been described by Hill (11) in 1921, Burns and Kohler (5) in 1925, and again by Burns (6) in 1935, was used to determine diameter of fiber measurements during the course of this study[6]. Precautions were taken to keep the calipers in as near perfect condition as possible. They were frequently returned to the factory for checking, cleaning and adjustment. Several calipers were retained for use over most of

[6]Averages obtained in this report were converted to microns.

the period covered by this study and the instruments were checked with one another at frequent intervals throughout the entire period. All measurements of fibers during the course of this investigation were made by two laboratory technicians, a factor which undoubtedly contributed to the accuracy of this phase of the work. Diameter measurements were taken at a point approximately one inch from the flesh or sheared end of the fiber. One hundred fibers from each of the samples were measured immediately after they were thoroughly cleansed with a solvent. Benzine was used during the early stage, but later carbon tetrachloride replaced benzine as a cleansing agent. Wool samples were kept in small envelopes which in turn were enclosed in a larger envelope with flap. Laboratory tests failed to reveal any significant differences in diameter measurements of the same fibers under the slightly varying laboratory conditions. Although shoulder, side and thigh samples were taken throughout the period of the entire experiment, diameter measurements of side and thigh samples were not measured after 1932. The averages obtained for diameter of shoulder samples are therefore not comparable to those obtained for the side and thigh samples.

Methods of Scouring Individual Fleeces

At the time of shearing, fleeces to be scoured individually were placed in bags each containing only one fleece, and a label showing ear tag number, grease fleece weight, sex of animal, and date of shearing was attached. After delivery to the Wool Research Scouring Laboratory at College Station the individual fleeces were weighed to the nearest 0.1 pound and graded immediately preceding scouring. The emulsion scouring operation was done in a small three-bowl commercial scouring machine. In the earlier stages of the experiment the single fleeces were not put through the dryer but were placed in containers and exposed to the sunlight to dry. However, as the number of fleeces in the test increased it became impractical to continue drying them by such a method. Accordingly, after determining that it was possible to put single fleeces through the dryer without a significant loss of scoured wool, such a procedure was followed. The temperature of the dryer was maintained at approximately 180 degrees Fahrenheit. After the scoured dried fleeces had been exposed to the atmosphere in the wool scouring laboratory for a period of at least 24 hours the scoured weights were recorded. Numerous preliminary tests including weighing on three successive days after scouring definitely showed that such a period is adequate for the normal regain of moisture of scoured fleeces exposed to the relatively constant atmospheric conditions which prevailed in the wool scouring laboratory. All shrinkages were recorded on the basis of both grease and scoured weights at the wool scouring laboratory.

The scouring agents consisted of a neutral soap, soda ash, and water heated to the usual temperatures used in commercial scouring of fine wools. Small scoured samples from each fleece were used in an extraction test for the purpose of determining the percentage of grease remaining in

the scoured wool. The amount of grease remaining in the scoured samples ranged consistently between 0.25 and 0.75 per cent, the average being closer to the latter.

Statistical Treatment of Data

Analysis of variance was made to determine the effects of age, type, and fertility on the various fleece characteristics studied. The number of individuals in the different sub-classes were unequal and therefore the data were analyzed by the method of expected numbers in the sub-classes, as reported by Snedecor and Cox (24).

The error term used to test the significance of the mean differences was the pooled year, age, type, fertility sub-class variance.

In all cases where mean differences or sources of variations were designated as significant, the t or F tests were on or below the .01 level.

The averages given in Tables 1 to 9 inclusive are based on actual numbers in the sub-classes. The summary Tables 10 and 11 show averages based on expected sub-class numbers. These averages differ but slightly from those which would have resulted had the actual numbers been used.

RESULTS OF INVESTIGATIONS

Influence of Age of Animal on Fleece Weight

The average fleece weights of unscoured and scoured wool for Rambouillet ewes in this study are shown for each age, 1 to 11 years inclusive, in Table 1. The heaviest production on the unscoured basis, B and C types averaged, was at 4 years, although the difference in weight between fleeces produced by 3 and 4 year old ewes respectively is not significant.

On a scoured basis, fleece weights for the three-year old ewes averaged 0.03 pound heavier than for the four-year-old animals as is shown in Table 2. This slight difference is not significant. Spencer and coworkers (25) reported a study conducted at the United States Sheep Experiment Station at Dubois, Idaho, in which three-year-old Rambouillet ewes produced approximately 0.5 pound more scoured wool per head than ewes of similar breeding one year older. In that study, however, the clean yields were based on the results of scouring a 250 gram (approximately 0.5 pound) sample taken from the side while in our experiment entire single fleeces were scoured separately.

As shown in Tables 1 and 2, fleece weights produced by one-year-old ewes were significantly lower both on unscoured and scoured basis than at any of the subsequent ages through the eighth year. There was, however, a gradual but steady decline in fleece with increasing age both on an unscoured and scoured basis after the ewes had reached the age of 4 years. The average annual decline in fleece weight between the ages of 4 and 8 years was approximately 0.3 pound unscoured and 0.13 pound scoured basis. The production of wool, unscoured basis, by 6-year-old ewes in this study was approximately 0.5 pound less than that produced by 3-year-old ewes. Calculated on a percentage basis, the decline in fleece

Table 1. Relation of Age, Fertility, and Type to Unscoured Fleece Weight of Rambouillet Ewes, 1923-1940, inclusive

Age in Years	Lambed During Year				Did Not Lamb During Year				All Records	
	C Type		B Type		C Type		B Type			
	No.	Ave. lbs.	No.	Ave. lbs.	No.	Ave. lbs.	No.	Ave. lbs.	No.	Ave. lbs.
1*	.....	.....	.....	.....	682	7.72	72	9.04	754	7.85
2	340	8.93	31	9.96	225	9.28	29	10.13	625	9.16
3	342	9.12	41	9.56	107	9.84	19	11.51	509	9.40
4	296	9.13	48	10.58	78	9.76	8	9.56	430	9.41
5	243	8.85	43	10.06	60	9.47	6	12.08	352	9.16
6	175	8.56	42	9.54	45	9.20	12	10.38	274	8.90
7	125	8.26	35	9.52	39	8.97	4	9.05	203	8.63
8	83	7.94	22	8.46	36	8.63	5	9.10	146	8.23
9	43	7.10	12	8.52	14	7.57	1	10.40	70	7.49
10	16	6.85	4	7.70	8	7.24	2	10.20	30	7.29
11	8	6.04	1	10.90	7	6.79	1	6.50	17	6.66
Totals**	1671	.....	279	.....	619	.....	87	.....	2656	.....
Averages**	.....	8.78	.....	9.69	.....	9.30	.....	10.40	.....	9.05

*None bred to lamb at this age.
**The records for the one year old ewes have not been included in these averages.

Table 2. Relation of Age, Fertility, and Type to Clean Fleece Weight of Rambouillet Ewes, 1923-1940, inclusive

Age in Years	Lambed During Year				Did Not Lamb During Year				All Records	
	C Type		B Type		C Type		B Type			
	No.	Ave. lbs.	No.	Ave. lbs.	No.	Ave. lbs.	No.	Ave. lbs.	No.	Ave. lbs.
1*	.....	.....	.....	.....	670	3.12	68	3.42	738	3.15
2	340	3.67	31	3.78	223	3.81	29	3.77	623	3.74
3	341	3.67	41	3.64	106	4.01	19	4.37	507	3.77
4	294	3.68	48	3.90	78	3.92	8	3.53	428	3.74
5	243	3.55	43	3.51	59	3.95	6	4.17	351	3.62
6	174	3.39	42	3.47	44	3.85	12	3.98	272	3.50
7	125	3.22	35	3.49	37	3.58	4	2.92	201	3.32
8	82	3.14	22	3.03	34	3.48	5	3.34	143	3.21
9	43	2.79	12	2.96	14	2.87	1	3.20	70	2.84
10	16	2.58	4	2.82	7	2.83	2	4.00	29	2.77
11	7	2.37	1	4.70	7	2.59	1	2.50	16	2.62
Totals**	1665	.....	279	.....	609	.....	87	.....	2640	.....
Averages**	.....	3.52	.....	3.55	.....	3.79	.....	3.86	.....	3.60

*None bred to lamb at this age.
**The records for the one year old ewes have not been included in these averages.

weight unscoured basis between the ages of four and eight years was approximately 13 per cent. On a scoured basis the 12 month fleeces produced by ewes during the eighth year of age averaged about 15 per cent less than that yielded by 3-year-old ewes.

On the basis of these data, when scoured 12 months French combing fine wool is selling at $1.00 per pound a 3-year-old ewe producing 3.77 pounds clean wool would return approximately $0.56 more annually from wool than an 8-year-old ewe which produced 3.21 pounds.

Influence of Age of Animal on Length of Staple

As shown in Table 3, the first fleece or that produced by ewes sheared at one year of age and converted to a 365-day growing period averaged 2.49 inches which is significantly greater in length than at any of the subsequent ages. The average fiber length produced by 2-year-old ewes was 2.39 inches, by 3-year-olds 2.31 inches, by 4-year-olds 2.28 inches, by 5-year-olds 2.22 inches, by 6-year-olds 2.18 inches, by 7-year-olds 2.09 inches, by 8-year-olds 2.05 inches. Between the ages of 1 and 6 years there was a decrease of approximately 0.3 inch or nearly 12 per cent in fiber length, an amount sufficient to place it in a shorter and less valuable length class. Between the ages of 1 and 8 years the average decrease in fiber length was 0.44 inch or about 18 per cent.

Table 3. Relation of Age, Fertility, and Type to Staple Length of Rambouillet Ewes, 1923-1940, inclusive

Age in Years	Lambed During Year				Did Not Lamb During Year				All Records	
	C Type		B Type		C Type		B Type			
	No.	Ave. inches	No.	Ave. inches	No.	Ave. inches	No.	Ave. inches	No.	Ave. inches
1*					693	2.51	71	2.27	764	2.49
2	338	2.39	31	2.14	211	2.46	29	2.14	609	2.39
3	343	2.33	43	2.10	108	2.37	18	2.14	512	2.31
4	296	2.30	46	2.10	79	2.35	8	1.99	429	2.28
5	244	2.23	42	2.00	59	2.35	6	2.07	351	2.22
6	171	2.18	42	1.99	46	2.33	11	2.15	270	2.18
7	127	2.10	36	1.96	38	2.23	5	1.76	206	2.09
8	84	2.03	22	1.90	35	2.22	5	1.84	146	2.05
9	42	1.91	12	1.77	14	1.94	1	1.90	69	1.89
10	16	1.80	4	1.70	8	2.00	2	1.90	30	1.85
11	8	1.80	1	1.80	7	1.73	1	1.50	17	1.75
Totals**	1669		279		605		86		2639	
Averages**		2.26		2.02		2.35		2.07		2.25

*None bred to lamb at this age.
**The records for the one year old ewes have not been included in these averages.

Bell (2) and coworkers at the Ohio Station had previously reported that age of the animal does not influence total annual wool growth for Merinos.

Influence of Age of Animal on Diameter of Fiber

The diameter of fiber as determined by the measurement of samples of wool from shoulder, side, and thigh, respectively, averaged slightly but significantly finer for fleeces produced during the first age year than at any of the subsequent ages. As shown in Tables 4, 5, and 6, the diameter of shoulder, side and thigh samples based on 1277 observations averaged 13.6, 13.6 and 14.6 microns respectively. The average diameter of the thigh sample is significantly coarser than the shoulder or side. The same tables show, however, that the average diameter of fiber produced during the first age year averaged 11.8, 12.2 and 13.2 microns for shoulder, side and thigh respectively, or slightly but significantly finer than is produced at any of the succeeding ages. A detailed examination of Table 7 will reveal that after the first (or lamb) fleece, diameter of wool fiber remains relatively constant. These findings differ from those reported in 1935 from work at this station (15) covering diameter of the mohair fiber which showed a pronounced tendency to become coarser as the age of Angora goat increased.

Table 4. Relation of Age, Fertility, and Type to Diameter of Fiber at Shoulder of Rambouillet Ewes, 1923-1940, inclusive

Age in Years	Lambed During Year				Did Not Lamb During Year				All Records	
	C Type		B Type		C Type		B Type			
	No.	Ave. microns	No.	Ave. microns	No.	Ave. microns	No.	Ave. microns	No.	Ave. microns
1*	.....	.....	.....	.....	701	11.7	75	12.8	776	11.8
2	342	13.1	31	14.6	220	12.9	29	14.6	622	13.2
3	351	13.1	43	14.7	109	13.0	18	13.7	521	13.2
4	298	13.6	48	14.7	79	13.3	8	13.7	433	13.6
5	244	13.3	44	15.1	59	13.0	6	14.6	353	13.5
6	175	13.2	42	14.4	46	13.5	10	15.1	273	13.5
7	127	13.4	36	14.4	38	13.1	5	16.3	206	13.6
8	84	13.8	22	14.4	34	12.7	5	11.9	145	13.6
9	41	12.3	12	14.4	15	13.5	1	11.2	69	12.9
10	16	13.8	4	13.0	8	10.9	2	12.8	30	12.9
11	8	13.5	1	16.5	7	14.0	1	14.2	17	13.9
Totals**	1686	.....	283	.....	615	.....	85	.....	2669	.....
Averages**	.....	13.3	.....	14.6	.....	13.0	.....	14.2	.....	13.4
Number and Average of all Records for the Period 1923-32, Inclusive									1277	13.6

*None bred to lamb at this age.
**The records for the one year old ewes have not been included in these averages.

Table 5. Relation of Age, Fertility, and Type to Diameter of Fiber at Side of Rambouillet Ewes, 1923-1932, inclusive

Age in Years	Lambed During Year				Did Not Lamb During Year				All Records	
	C Type		B Type		C Type		B Type			
	No.	Ave. microns	No.	Ave. microns	No.	Ave. microns	No.	Ave. microns	No.	Ave. microns
1*					320	12.1	59	13.0	379	12.2
2	166	13.5	25	14.9	95	13.3	22	14.8	308	13.6
3	185	13.0	34	14.7	53	12.5	11	13.9	283	13.2
4	135	13.8	36	14.9	42	13.3	6	13.6	219	13.9
5	96	13.7	34	15.1	21	13.4	4	15.2	155	14.0
6	63	13.4	28	14.1	17	13.8	6	14.3	114	13.7
7	48	13.4	26	14.4	16	12.4	2	16.4	92	13.5
8	37	13.8	13	13.2	10	12.9	3	13.1	63	13.5
9	11	12.6	8	13.9	6	11.9	1	12.9	26	12.9
10	3	14.4	4	11.8	1	12.7	2	12.6	10	12.8
11	2	11.8	1	13.7	3	13.0	1	12.2	7	12.7
Totals**	746		209		264		58		1277	
Averages**		13.4		14.5		13.1		14.3		13.6

*None bred to lamb at this age.
**The records of the one year old ewes have not been included in these averages.

Table 6. Relation of Age, Fertility, and Type to Diameter of Fiber at Thigh of Rambouillet Ewes, 1923-1932, inclusive

Age in Years	Lambed During Year				Did Not Lamb During Year				All Records	
	C Type		B Type		C Type		B Type			
	No.	Ave. microns	No.	Ave. microns	No.	Ave. microns	No.	Ave. microns	No.	Ave. microns
1*					320	13.1	59	13.9	379	13.2
2	166	14.3	25	15.8	95	14.1	22	15.9	308	14.5
3	185	13.9	34	15.7	53	13.5	11	15.0	283	14.1
4	135	14.9	36	16.0	42	14.3	6	14.1	219	14.9
5	96	15.0	34	16.4	21	14.2	4	15.9	155	15.2
6	63	14.6	28	15.4	17	14.7	6	15.5	114	14.9
7	48	14.6	26	16.1	16	13.4	2	17.3	92	14.9
8	37	15.2	13	13.7	10	14.0	3	13.5	63	14.7
9	11	14.2	8	16.0	6	13.5	1	13.9	26	14.6
10	3	15.2	4	13.2	1	11.2	2	14.0	10	13.7
11	2	13.1	1	15.0	3	14.7	1	14.0	7	14.1
Totals**	746		209		264		58		1277	
Averages**		14.5		15.7		14.0		15.3		14.6

*None bred to lamb at this age.
**The records of the one year old ewes have not been included in these averages.

Influence of Age of Animal on Body Weight

The average weights of the ewes by ages shortly after shearing are shown in Table 8. The data show that the Rambouillet ewes used in these studies continued to increase in body weight to and including the sixth year of age. The average weight of 766 sheared yearling ewes was 82 pounds. Six hundred twenty-seven 2-year-old ewes averaged 98 pounds, five hundred twenty-two 3-year-old ewes averaged 107 pounds, four hundred thirty-one 4-year-old ewes averaged 111 pounds, the maximum weight being reached at 5 and 6 years of age when body weights averaged 114 pounds. After ewes had reached the age of 6 years there was a tendency toward a slight but steady decline in body weight. The Rambouillet ewes used in this study averaged, as yearlings, 16 per cent less in weight than 2-year-olds, 23 per cent less than 3-year-olds, and 26 per cent less than 4-year-olds.

Influence of Staple Length on Diameter of Fiber

The longer staple fleeces produced by Rambouillet ewes tended to be very slightly finer in diameter as shown in Table 12. The correlation of length of fiber and diameter for all ages combined was only −.19, but

Table 7. Relation of Age and Type of Animal to Diameter* of Fiber at Shoulder, Side and Thigh of Rambouillet Ewes

Age in Years		Shoulder (1923-40)		Side (1923-32)		Thigh (1923-32)	
		C Type	B Type	C Type	B Type	C Type	B Type
1	Average	11.7	12.8	12.1	13.0	13.1	13.9
	Number	701	75	320	59	320	59
2	Average	13.0	14.6	13.4	14.8	14.2	15.8
	Number	562	60	261	47	261	47
3	Average	13.1	14.4	12.9	14.5	13.8	15.5
	Number	460	61	238	45	238	45
4	Average	13.5	14.5	13.7	14.7	14.7	15.7
	Number	377	56	177	42	177	42
5	Average	13.2	15.1	13.7	15.1	14.8	16.4
	Number	303	50	117	38	117	38
6	Average	13.3	14.5	13.5	14.1	14.6	15.4
	Number	221	52	80	34	80	34
7	Average	13.3	14.6	13.1	14.5	14.3	16.2
	Number	165	41	64	28	64	28
8	Average	13.5	14.0	13.6	13.2	15.0	13.7
	Number	118	27	47	16	47	16
9	Average	12.6	14.2	12.4	13.9	13.9	16.0
	Number	56	13	17	8	17	8
10	Average	12.8	13.0	14.0	12.1	14.2	13.4
	Number	24	6	4	6	4	6
11	Average	13.7	15.4	12.5	13.0	14.0	14.5
	Number	15	2	5	2	5	2

*Microns.

was significant. Spencer and associates (25) in 1928, reported that fineness of wool fiber in Rambouillets was practically unassociated with length of staple giving a coefficient of correlation of $-.04$. In their study as in ours there was an important relationship between length of staple and clean fleece weight. Clean fleece weight tended to increase with length of staple.

Influence of Fertility on Fleece Weight and Shrinkage

Unscoured and scoured fleece weight data both for fertile and non-lambing ewes were analyzed in this study. Ewes that did not produce lambs at the several ages yielded fleeces that weighed slightly but significantly heavier than those produced by ewes of comparable age which produced lambs. Reference to Table 1 reveals that on an unscoured basis 225 fleeces produced by 2-year-old C type ewes which did not lamb averaged 0.35 pound more unscoured wool per head than 340 ewes of the same age that produced lambs. One hundred seven unscoured fleeces from 3-year-old non-lambing C type ewes averaged 0.72 pound more than those produced by ewes of the same age producing lambs. Seventy-eight unscoured fleeces from 4-year-old non-lambing C type ewes averaged 0.63 pound more than 296 fleeces from 4-year-old ewes which produced lambs. As shown in Table 2, two hundred twenty-three fleeces produced by 2-year-old non-

Table 8. Relation of Age, Fertility and Type to Body Weight of Rambouillet Ewes, 1923-1940, inclusive

Age in Years	Lambed During Year				Did Not Lamb During Year				All Records	
	C Type		B Type		C Type		B Type			
	No.	Ave. lbs.	No.	Ave. lbs.	Ave.	Ave. lbs.	No.	Ave. lbs.	No.	Ave. lbs.
1*					695	81	71	85	766	82
2	342	95	29	96	227	101	29	96	627	98
3	353	104	43	106	107	116	19	117	522	107
4	298	109	48	111	77	120	8	114	431	111
5	245	112	44	110	60	122	7	115	356	114
6	177	112	41	114	47	118	12	121	277	114
7	127	111	36	114	38	114	5	118	206	112
8	83	110	22	108	36	115	5	119	146	112
9	43	106	12	112	15	114	1	96	71	109
10	16	117	4	109	8	106	2	117	30	113
11	8	106			6	109	1	88	15	106
Totals**	1684		279		615		88		2666	
Averages**		106		109		114		110		108

*None bred to lamb at this age.
**The records of the one and eleven year old ewes have not been included in these averages.

lambing C type ewes averaged 0.14 pound more clean wool than 2-year-old ewes of the same type which produced lambs; 3-year-old non-lambing ewes produced 0.34 pound more than 3-year-old fertile ewes; 4-year-old non-lambing ewes produced 0.24 pound more per head than the 4-year-old fertile ewes; 5-year-old non-lambing ewes produced 0.4 pound more per head than 5-year-old fertile ewes; and 6-year-old non-lambing C type ewes averaged 0.46 pound more scoured wool than was produced by 6-year-old fertile ewes.

There were, as shown in Table 9, no significant differences in wool shrinkages from scouring within the respective C and B types of the fertile and non-lambing ewes. The shrinkage of 340 fleeces produced by 2-year-old C type ewes that lambed averaged 58.6 per cent as compared with 58.8 per cent for fleeces from 223 non-lambing ewes of similar age and type. Shrinkage for 341 fleeces from fertile 3-year-old C type ewes was 59.4 per cent as compared with 59.1 per cent for 106 fleeces produced by non-lambing C type ewes. Two hundred ninety-four fleeces from 4-year-old C type fertile ewes showed an average shrinkage of 59.4 per cent as compared with 59.7 per cent shrinkage of fleeces from 78 non-lambing 4-year-old C type ewes.

Fertility, as shown in Table 10, exerted some influence on unscoured fleece weight since the non-lambing ewes averaged 9.47 pounds as compared with 8.90 pounds for ewes that lambed during the year or a difference of

Table 9. Relation of Age, Fertility and Type to Shrinkage Percent of Fleeces of Rambouillet Ewes, 1923-1940, inclusive

Age in Years	Lambed During Year				Did Not Lamb During Year				All Records	
	C Type		B Type		C Type		B Type			
	No.	Ave. %	No.	Ave. %	No.	Ave. %	No.	Ave. %	No.	Ave. %
1*	.....	.....	.....	.....	670	59.3	68	62.1	738	59.5
2	340	58.6	31	62.1	223	58.8	29	62.4	623	59.0
3	341	59.4	41	61.6	106	59.1	19	61.7	507	59.6
4	294	59.4	48	62.8	78	59.7	8	62.5	428	59.9
5	243	59.7	43	64.7	59	57.8	6	64.8	351	60.1
6	174	60.1	42	63.3	44	58.1	12	61.7	272	60.3
7	125	61.0	35	63.4	37	59.6	4	68.0	201	61.3
8	82	60.2	22	63.9	34	59.1	5	63.8	143	60.6
9	43	60.6	12	65.1	14	61.9	1	69.0	70	61.7
10	16	62.1	4	63.8	7	60.9	2	61.0	29	62.0
11	7	61.4	1	57.0	7	60.9	1	61.0	16	60.9
Totals**	1665	.....	279	.....	609	.....	87	.....	2640	.....
Averages**	.....	59.6	.....	63.2	.....	59.0	.....	62.7	.....	59.9

*None bred to lamb at this age.
**The records of the one year old ewes have not been included in these averages.

Table 10. Summary Showing the Effect of Fertility on Certain Fleece Characters and Body Weight*

	Lambed During Year		Did Not Lamb During Year		Mean Difference
	No. Records	Average	No. Records	Average	
Fleece Weight (Unscoured)	1950	8.90	706	9.47	0.57**
Fleece Weight (Scoured)	1944	3.54	696	3.81	0.27**
Shrinkage Percent	1944	60.03	696	59.52	0.51**
Staple Length (Inches)	1948	2.23	691	2.31	0.08**
Fiber Diameter at Shoulder (Microns)	1969	13.5	700	13.2	0.30**
Animal Weight (Pounds)	1963	105.9	703	113.5	7.6 **

*The records of the one year olds have not been included in these averages.
**Means significant on .01 level.

0.57 pound in favor of the dry ewe. Scoured fleece weight produced by the non-lambing ewes averaged 0.27 pound heavier than those produced by the fertile ewes.

Workers at the Ohio Station (2), in 1936, reported that pregnancy alone does not influence the rate of wool growth by well fed Merino sheep, however, parturition and the starting of the milk flow exerted a retarding influence on growth of the wool fiber.

In this study, during the lambing period ewes with lambs were in most instances confined in dry lot at headquarters for a relatively short period. It is believed that as a result of this management ewes showing a tendency toward openness of fleece may have accumulated slightly more foreign matter in the wool which probably increased shrinkage.

Influence of Fertility on Staple Length

There was very slight advantage in length of fiber in fleeces produced by the ewes which failed to produce lambs at any of the respective ages over those which had currently lambed. As shown in Table 3, the 211 fleeces produced by C type non-lambing 2-year-old ewes showed an average fiber length of 2.46 inches while fleeces from 338 fertile C type ewes of the same age produced 2.39 inches of fiber or 0.07 inch less than the non-lambing ewes. A comparison of the fiber length of the fertile and non-lambing C type ewes revealed an advantage of 0.04 inch and 0.05 inch in favor of the non-lambing ewes at 3 and 4 years respectively. A study of Table 3 reveals however that the differences in fiber length in favor of the non-lambing C type ewes becomes more pronounced between the ages of 4 and 8 years.

Influence of Fertility on Fineness of Fiber

The diameter of fiber produced by pregnant ewes was slightly coarser on the average than that produced by non-lambing ewes in the same age

groups. Bosman (3) has reported that pregnancy does not influence Merino wool fineness, however a finer quality fiber is produced during the suckling or lactation period. In our study diameter measurements were those covering fiber growth during pregnancy or before lambing. No practical importance is attached to the very slight but significant difference in fineness between the fertile and non-lambing groups as shown in Table 4. A possible explanation of the fact that fertile ewes produced a slightly coarser fiber than the non-lambing ewes is that the fertile ewes received a more liberal feed supplement than did the dry ewes.

Wilson (26), in 1931, reported that wool produced by sheep on submaintenance ration showed slower growth, a finer fiber diameter or thickness, and lighter clean weight fleece than is produced by comparable animals full fed on a balanced ration. Maré and Bosman (20) (1934), at the conclusion of a study of the effect of the plane of nutrition on the Merino, reported that this factor is of great significance to the Merino stud breeder. It was shown in their study that quantity and quality in a Merino fleece are influenced by the nutrition of the animal. Under-feeding for 18 months reduced the scoured fleece weights from 5.55 pounds to 4.21 pounds while fiber fineness was reduced from 17.9 microns at the beginning of the test to 14.3 microns at the end of the period. The study further showed that fiber diameter was restored to normal under adequate nutrition.

Influence of Fertility on Body Weight

The C type fertile 2-year-old ewes, as shown in Table 8, shortly after shearing averaged 95 pounds per head or 6 pounds less than non-lambing ewes; 3-year-old fertile ewes under similar conditions averaged 104 pounds or 12 pounds lighter than 3-year-old non-lambing C type ewes; 4-year-old C type fertile ewes averaged 109 pounds or 11 pounds lighter than non-lambing C type ewes of the same age; while 5-year-old ewes of similar type averaged 112 pounds or 10 pounds less than non-lambing ewes. Non-lambing 2-year-old C type ewes averaged 21 pounds or 17 per cent less, than 5-year-old non-lambing ewes of similar type, while fertile 2-year-old C type ewes weighed 17 pounds or 15 per cent less than fertile 5-year-old ewes of similar type. These differences in body weight between the respective age groups are believed to be due largely to condition of fleshing.

Influence of Body Type on Fleece Weight and Shrinkage

Texas Station workers were among the first in this country to recognize the relationship of body type to wool production in Rambouillet sheep. Not until this study had been underway for several years was it rather definitely indicated and reported (14) (16) that in the same flock C type Rambouillet ewes produced fleeces which on a scoured basis yielded approximately as much clean wool per head as ewes with heavy skin fold development.

The average unscoured fleece weight of 279 fleeces from B type ewes that currently dropped lambs, as shown in Table 1, was 9.69 pounds or

0.91 pound heavier than 1671 unscoured fleeces produced currently by C type fertile ewes. Also in the same table it is shown that among ewes which did not lamb 87 fleeces produced by B type ewes averaged 10.40 pounds as compared with 9.30 pounds for 619 unscoured fleeces produced by C type ewes that did not lamb, or a difference of 1.10 pounds in favor of the B type ewes insofar as unscoured fleece weight is concerned. On a scoured basis, however, as shown in Table 2, the one pound difference favoring the B type ewes practically disappeared. Average clean weight of 1665 fleeces produced by C type ewes that lambed during the year was 3.52 pounds as compared with an average weight of 3.55 pounds clean basis for 279 fleeces produced by B type ewes which had currently produced lambs. Also the average clean weight of 609 fleeces produced by C type ewes which did not currently produce lambs was 3.79 pounds as compared with 3.86 pounds for 87 fleeces produced by B type ewes that did not lamb.

As shown in Table 9, the average shrinkage of 279 fleeces produced by B type fertile ewes was 63.2 per cent as compared to 59.6 per cent for 1665 fleeces produced by C type fertile ewes. Among the groups which did not lamb currently 87 fleeces produced by B type ewes showed an average shrinkage of 62.7 per cent as compared with 59.0 per cent for 609 fleeces produced by C type ewes which did not lamb currently.

It is observed that in each instance the fleeces produced by B type Rambouillet ewes shrank significantly greater than those produced by C type ewes.

In a comparison of the fleeces produced by the non-lambing ewes as is also shown in Table 9 those from the B type ewes shrank 3.7 points more than the fleeces from the C type ewes; also in the comparison between the B and C type fertile ewes the fleeces from the B type ewes shrank 3.6 points more than did the fleeces produced by the C type ewes.

Nordby (22) has recently reported a significant difference in shrinkage of wools 2 inches and 3.4 inches in length produced by yearling Rambouillet ewes. In his study the shorter fibered fleeces shrank 63 per cent as compared with an average of 55 per cent for the longer staple fleeces.

Spencer and coworkers (25) have also reported that the weight of actual clean wool in the fleece is only very slightly affected by neck folds. In their study smooth-necked Rambouillet ewes produced fleeces that were freer from heavy weights of grease and dirt, longer in staple, slightly finer, of a little higher character and less dense than the fleeces from the more wrinkled ewes.

The average clean fleece weights of the C type and of the B type ewes, as shown in Table 11, did not differ significantly.

It is generally true that fleece shrinkages will vary widely depending upon type of sheep and kind of range upon which they are grazed. It may be safely predicted however that the fleeces produced by the heavier skin folded type will usually shrink several points more than fleeces produced by smooth-bodied animals of similar breeding under similar grazing conditions.

Table 11. Summary of All B Type with All C Type Rambouillet Ewes in These Experiments

	C Type		B Type		Mean Difference
	No. Records	Average	No. Records	Average	
Fleece Weight (Unscoured)	2290	8.91	366	9.93	1.02**
Fleece Weight (Scoured)	2274	3.60	366	3.66	0.06
Shrinkage Percent	2274	59.41	366	62.93	3.52**
Staple Length (Inches)	2274	2.28	365	2.05	0.23**
Fiber Diameter at Shoulder (Microns)	2301	13.2	368	14.5	1.30**
Animal Weight (Pounds)	2299	107.9	367	107.9	0.00

**Means significant on .01 level.

An increased length of staple (within breeds) is quite generally associated with a direct increase in clean fleece weight. However, the fleeces from the C type ewes in this study, which were significantly longer in staple than those from the B type ewes, yielded clean wool of the same average weight rather than greater. On the other hand, when staple length was correlated with clean fleece weights of individual ewes of the same age, both types included, there was a significant correlation at each age. This showed that increased staple length resulted in a very definite increase in clean weight of wool. These findings are in agreement with those of Pohle and Keller (23) (1943), who have reported that staple length has a great influence on clean fleece weight.

Influence of Body Type on Staple Length

As shown in Table 3, C type Rambouillet ewes consistently produced a longer wool staple than did the B type ewes of similar ages. Also as is shown in Table 11, the fiber length of 2274 fleeces produced by C type ewes averaged 2.28 inches as compared with an average staple length of 2.05 inches for 365 fleeces produced by B type ewes. A number of fleeces produced by the C type ewes were classified as strictly combing, being 2.5 inches or more in staple length. Spencer (25) and coworkers reported in 1928 that freedom from body folds was correlated with increased length of staple, slightly finer fibers and a very slight reduction in scoured fleece weight.

Influence of Body Type on Diameter of Fiber

The diameter of wool fiber produced by C type ewes was significantly finer than wool produced by B type ewes of corresponding ages. It has been observed that coarser fibers are produced on the crest of skin folds or wrinkles than on unwrinkled portions of the body, which may be one of the factors that accounts for the difference in fiber diameter between B and C type Rambouillet ewes.

As shown in Table 4, fiber diameter of 1686 shoulder samples from fertile C type ewes averaged 13.3 microns as compared with an average of 14.6 microns for shoulder samples from 283 fleeces produced by fertile B type ewes. Diameter of 746 side samples produced by fertile C type ewes, as shown in Table 5, averaged 13.4 microns as compared with an average of 14.5 microns for side samples from 209 fleeces produced by fertile B type ewes. Also as is shown in Table 6, the fiber diameter of 746 thigh samples from fertile C type ewes averaged 14.5 microns as compared with an average of 15.7 microns for thigh samples from 209 fleeces produced by fertile B type Rambouillet ewes.

As is clearly shown in Table 7, the diameters of wool fibers from shoulder, side and thigh areas respectively are finest during the first year's production. Fiber diameter at all subsequent ages to and including the 9th year of age, although slightly but significantly coarser than the first year's production, show relatively small variation in diameter from one age to another after the first or yearling age.

Influence of Type on Body Weight

As has been stated previously in this bulletin, "off type" or undesirable animals were removed from the flock either at the weaning age or as yearlings. The average weights of the C and B type ewes are shown by ages in Table 8. There was an increase in body weight for both B and C type ewes until the fifth or sixth year after which there was a tendency toward a gradual decline. At one year of age 695 C type females averaged 81 pounds as compared with an average weight of 85 pounds for 71 B type females. There was a gradual increase in weight to 112 pounds for 177 fertile 6-year-old C type ewes as compared with 114 pounds for 41 fertile B type ewes. At 6 years of age 47 C type non-lambing ewes averaged 118 pounds as compared to a 121 pound average of 12 non-lambing B type ewes of similar age.

Under conditions of inadequate nutrition during extended periods, however, body weight is reduced. Maré and Bosman (20), in 1934, reported that during a nine months' period of under-feeding body weights of Merino sheep were reduced approximately 16 per cent, whereas on a full ration a gain of approximately 11 per cent over initial weights resulted.

Influence of Type of Rambouillet Rams on Fleece Weight, Shrinkage, Staple Length, and Diameter of Fiber

During the course of this study records of fleeces produced by Rambouillet rams, including stud and range animals, were kept. Unscoured fleece weights produced by a representative number of rams at each age through and including the fourth year consistently showed that the B type rams had an advantage over the C type rams of approximately one pound at each age.

The shrinkage of 460 fleeces produced by C type rams averaged 62.8 per cent as compared with 64.6 per cent for 130 fleeces produced by B type

Table 12. Coefficients of Correlations of Certain of the Fleece Characters in Wool Production at the Different Ages of Registered Range Rambouillet Ewes Used in This Study

Characters Correlated	Age in Years									Total	
	1	2	3	4	5	6	7	8	9–12	2–12	1–12
Fleece weight:											
Clean weight	.93**	.76**	.78**	.78**	.73**	.77**	.84**	.83**	.84**	.80**	.84**
Shrinkage %	.35**	.41**	.40**	.42**	.41**	.46**	.20**	.24**	.32**	.34**	.34**
Staple length	.35**	.14**	.17**	.15**	.10	.14*	.23**	.26**	.36**	.24**	.15**
Diameter fiber	.25**	.08	—.02	.03	—.02	.00	—.01	.10	.07	.03	.16**
Body weight	.53**	.37**	.34**	.30**	.28*	.21**	.26**	.46**	.43**	.26**	.41**
Clean weight:											
Shrinkage %	—.10*	—.25**	—.25**	—.22**	—.31**	—.20**	—.32**	—.33**	—.23*	—.28**	—.23**
Staple length	.54**	.49**	.48**	.47**	.48**	.49**	.51**	.58**	.60**	.56**	.42**
Diameter fiber	.09*	.15**	.04	.09	—.10	.05	—.05	—.01	—.05	.04	.13**
Body weight	.54**	.37**	.42**	.34**	.40**	.27**	.34**	.40**	.46**	.26**	.41**
Shrinkage %:											
Staple length	—.35**	—.42**	—.43**	—.44**	—.48**	—.51**	—.54**	—.58**	—.45**	—.48**	—.44**
Diameter fiber	.12**	—.10*	—.09*	—.08	.10	—.09	.06	.17*	.25*	—.01	.02
Body weight	.05	.05	—.07	—.02	—.01	—.05	—.13	.09	—.03	.02	.05
Staple length:											
Diameter fiber	—.11*	—.04	—.11*	—.04	—.12*	—.05	—.23**	—.24**	—.29**	—.11**	—.19**
Body weight	.15**	.08	.12**	.04	.18**	.08	.08	.07	.25*	—.02	—.18**
Diameter fiber:											
Body weight	.25**	—.03	.06	—.08	—.15**	.08	—.01	.04	.14	.02	.23**
Number	722	585	495	420	345	262	197	138	112	2554	3276

*Significant on .05 level.
**Significant on .01 level.

rams. Differences in fleece weights between types disappeared in scouring.

Staple length of 741 fleeces produced by C type rams averaged 2.42 inches as compared with a length of 2.25 inches for 172 fleeces from B type rams or an advantage of 0.17 inch in favor of the smooth-bodied type. With respect to body weight animals of each type averaged approximately the same at each of the several ages.

Diameter of wool fibers from 551 shoulder samples from C type Rambouillet rams at one year averaged 11.7 microns as compared with an average of 12.4 for fibers from 97 shoulder samples from B type one year old Rambouillet rams. These findings are in similar order to fiber diameter measurements taken from the shoulder area on C and B type Rambouillet ewes.

Correlation of Certain Fleece Characters at the Different Ages

The coefficients of correlation of unscoured fleece weight, clean fleece weight, shrinkage of fleece, staple length and diameter of wool fiber of all ewes at the different ages, with each other are shown in Table 12. The correlation coefficients between unscoured and scoured fleece weights at all ages were relatively high[7]. The correlation between unscoured fleece weight and staple length was highly significant even though rather low. That between unscoured fleece weight and body weight was slightly higher and was highly significant. The correlation of clean fleece weight and body weight was highly significant and fairly high.

The clean fleece weight in relation to staple length showed a high correlation at each of the respective ages. The shrinkages of fleece in relation to staple length showed a uniform but negative correlation for each of the respective ages which indicates that as the staple length increases there is a general tendency for the shrinkage of the fleece to decrease. Also in a comparison of staple length in its relation to diameter of fiber the correlation was small and negative but highly significant.

DISCUSSION

Merinos and Rambouillets have been predominant on the sheep ranges in Texas because of their adaptability to the conditions. At the inception of the sheep industry in Texas, range breeders were engaged in sheep raising primarily for the production of wool. However, during the past 30 years the range sheep industry has been converted generally to a wool and mutton basis.

Under the original program with wool production as the main incentive, breeders generally tolerated and in many instances were partial to sheep possessing a medium to heavy development of skin folds. Their contention was that the increased skin area of the folded or wrinkled Merino or Rambouillet sheep resulted in the production of an increased poundage

[7]The degree of relationship between two variables increases as correlation coefficient approaches unity, either 1.00 or – 1.00. No association is indicated by a coefficient of 0.00. The significance or lack of significance depends on both the size of the correlation coefficient and the number of observations on which it is based.

of wool per animal. The production of wool by relatively smooth-bodied Merino and Rambouillet sheep as compared with those which carry a number of well developed skin folds or wrinkles has long been a subject of controversy among sheep breeders both in this country and abroad. They agree in principle, however, that skin folds from a utilitarian standpoint are in many respects undesirable.

As a result of the increased demand for lamb and mutton during more recent years, Texas sheep breeders have become partial to the smooth-bodied type in the Rambouillet and Merino since lambs or muttons carrying a medium to heavy skin fold development have been severely discriminated against by purchasers of feeders. Furthermore, the skins from wrinkly sheep are less valuable than those from smooth-bodied sheep as discussed by Arnold (1) in 1925. Another important reason why Rambouillet and Merino sheep showing heavy skin fold development have, in the Texas area, met with increasing disfavor among breeders is that they are believed to be more susceptible to strike by blow flies, progenitors of both the wool worm and the screw worm maggot, than are sheep devoid of skin folds or wrinkles. Mackerras (18), in 1936, in Australia reported breech strikes on plain, medium and very wrinkly breeches of Merino ewes over a three-year period. In his study the average percentage of strikes (blows) per annum on the plain type was 35, on the medium 126, and on the very wrinkly type 233.

A large number of individual fleeces (2640) produced by registered Rambouillet ewes were scoured during the course of this study and a wide range of variation in the weights of scoured fleeces between the respective age groups was shown. Scoured fleeces, 12 months growth, produced by ewes developed and handled under representative range conditions in southwestern Texas averaged 3.6 pounds for ages 1 to 11 years with a range in variability from approximately 2 to 6.3 pounds. Obviously then, with clean 12 months fine wool at a valuation of $1.00 per pound there was a difference between the lightest and heaviest shearing ewes of $4.30 in favor of the heavy shearing ewe. It is realized that a goal of 6 pounds clean wool for all Rambouillet ewes grazed under range conditions can probably never be attained. It does however serve to emphasize the importance of clean fleece weight in its relationship to increased efficiency in range sheep production. As has been stated, B type ewes produced fleeces which on an unscoured basis averaged one pound heavier at 12 months growth than those produced by C type or smooth-bodied ewes. On a scoured basis this difference disappeared. The fleeces produced by the B type ewes which carried considerable skin fold development showed an average shrinkage of 62.93 per cent as compared with 59.41 for those produced by the C type or smooth-bodied ewes, or a difference of 3.52 points. Texas wool growers quite generally evaluate their annual wool clip on the basis of unscoured fleece weights. Hence as a result of this practice sufficient emphasis has not been given to clean weights of fleeces. However, until the economics of wool marketing in Texas have been developed to the point where the individual producer is paid directly on the

basis of clean wool, considerable attention should be continued to be given by the producer to unscoured fleece weights even though it may be necessary to tolerate some skin folds to maintain unscoured fleece weight.

Density of wool fibers per unit area of skin surface, although recognized as an important factor in relation to fleece weight in fine wool sheep, was not measured in our experiment. It is generally recognized that fine wool fleeces of average or better length showing compactness or density not only yield more wool than open fleeces but the dense fleeces are likely to be more desirable from the manufacturer's standpoint.

Studies relating to density of wool fibers on fine wool sheep have been reported by a number of workers. Hultz and Paschal (13) in 1930 reported a study with a low of 14,332 and a high of 54,600 fibers per square inch on the shoulder area of Rambouillets that had been exhibited at the International Livestock Exposition in Chicago. Bell and Associates (2) in 1936 reported an average density per square inch of skin surface on ten American Merino ewes and one ram as being 23,985 as compared with an average of 40,156 on ten Tasmanian Merino ewes and one ram. Bosman (4) in 1941 in South Africa reported that 50 well-bred Merino ewes devoid of skin folds showed a low of 30,200 to a high of 71,600 wool fibers per square inch. Bosman also reported that Merino stud flocks in South Africa may be expected to produce between 30,000 and 60,000 wool fibers per square inch in contrast to an expectation of 15,000 to 25,000 for grade fine wool flocks. This is in close agreement with Carter (7) in Australia, who in 1942 reported that fiber density among mature Australian Merinos varies from as low as 15,000 to as high as 80,000 per square inch of skin area. He estimated that the best Australian studs averaged better than 50,000 fibers per square inch. Carter (8) in 1943 also directed attention to follicle types and skin fold patterns in the Australian Merino sheep.

A determination of the number of wool fibers per unit area on the unshorn sheep is somewhat technical and involved. It is therefore believed by workers in the field at the Texas Station that individual scoured fleece weights will provide adequate information to stud breeders[5] desirous of further improving fleece weight.

Obviously scoured fleeces weighing 5 pounds or more for 12 months' production by Rambouillet ewes may be expected to show considerable density and good length of staple. The average unscoured weight of Texas fleeces in 1942 according to the National Association of Wool Manufacturers (21) was 7.2 pounds. Based on a shrinkage of 61 per cent, estimated by that authority, the average scoured fleece weight for Texas wool in 1942 was only 2.8 pounds, a figure which no doubt could be increased as a result of systematic culling.

Hill (9) in 1921 described a method of culling light shearing sheep from range flocks by a "touch" system in which much emphasis was placed on density and length of staple. In 1921 he also reported (10) a sufficiently

[5]Breeders who may be interested in gaining additional information relating to clean fleece weights should communicate with the Agricultural Experiment Station Wool Scouring Laboratory at College Station, Texas, for detailed information with reference to methods of selecting and packing fleeces, also scouring cost.

high correlation between a fleece produced after maturity and the weight of subsequent fleeces produced by the same sheep to make culling effective. Light shearing ewes could be culled from Texas range flocks based on such a method, as pointed out by Lush and Jones (17) in 1923. McMahon (19) in New Zealand in 1940 suggested that under a wisely directed program of progeny testing and culling, unscoured fleece weights could be increased by one pound in a single generation.

This study of the influence of age, type, and fertility on Rambouillet ewes on fineness of fiber, fleece weight, length of staple and body weight has made available to breeders of Rambouillet and Merino sheep considerable information that should prove helpful.

ACKNOWLEDGMENTS

The authors make grateful acknowledgment of the contributions and services of E. M. Peters, formerly Superintendent of the Ranch Experiment Station, and to O. L. Carpenter, Livestock Overseer, whose daily care of the sheep and careful attention to the routine records of the breeding flock has contributed greatly to the value of the results reported in this bulletin. Acknowledgment is also made to the painstaking work in the wool laboratory by Mrs. Emmett Smith for the faithful and painstaking work in obtaining diameter of fiber measurements, and finally to Professor C. B. Godbey, of the Department of Genetics, A. & M. College of Texas, for helpful suggestions relating to the arrangement and presentation of the data.

SUMMARY AND CONCLUSIONS

1. In this study, extending over 18 years, the influence of age, body type and fertility in Rambouillet ewes on (a) fleece weight and shrinkage, (b) staple length, (c) fineness of fiber, and (d) body weight after the spring shearing has been reported.

2. Maximum production of unscoured wool basis 12 months growth was returned by both the B and C type ewes during the fourth age year. The differences however in unscoured fleece weights during the third and fourth years were not significant.

3. Three hundred sixty-six unscoured fleeces from B type Rambouillet ewes averaged 9.93 pounds as compared with an average of 8.91 pounds for 2296 fleeces from C type ewes, or 1.02 pounds heavier for the B type ewes.

4. All differences in fleece weight practically disappeared in scouring, and on a clean basis the average fleece weight produced by the C type Rambouillet ewes was 3.60 pounds as compared with 3.66 pounds for the B type ewes, or a difference of 0.06 pound which was not significant.

5. Three hundred sixty-six fleeces from B type ewes showed an average shrinkage of 62.93 per cent in scouring as compared with 59.41 per cent for 2274 fleeces produced by C type ewes. The shrinkage of 460 fleeces produced by C type Rambouillet rams averaged 62.8 per cent in scouring

as compared with 64.6 per cent for 130 fleeces produced by B type rams. Differences in unscoured fleece weights as produced by the C and B types practically disappeared in scouring.

6. Twenty-two hundred seventy-four fleeces produced by C type Rambouillet ewes showed an average staple length of 2.28 inches as compared with 2.05 inches for 365 fleeces produced by B type Rambouillet ewes. This is a difference of 0.23 inch, an amount which in many instances was sufficient to place C type fleeces in the strictly combing class.

7. Staple length after adjustment to 12 months growth, produced by ewes sheared at one year of age averaged 2.49 inches, or a significantly greater length than staple produced at any of the succeeding ages. A significant positive correlation was found between staple length and unscoured fleece weight, and also between staple length and clean fleece weight.

8. Between the ages of 1 and 6 years the staple length had decreased 0.31 inch or about 12 per cent. Between the ages of 1 and 8 years staple length had decreased 0.44 inch or about 18 per cent.

9. After the fourth year there was a slight but consistent decline in fleece weight both on an unscoured and scoured basis at each subsequent age year. The decline in unscoured fleece weight between the ages of 4 and 8 years averaged 1.18 pounds and on a scoured basis 0.53 pound. This represents an average annual decline of approximately 0.3 pound unscoured and 0.13 pound clean wool.

10. The fiber diameter of wool produced by Rambouillet ewes during the first age year averaged slightly but significantly finer than at any of the subsequent ages. Diameter of wool fiber, however, remained relatively constant after the first year.

11. The wool produced by the C type or smooth-bodied ewes was more uniform in diameter or fineness than that produced by B type ewes and averaged 0.23 inch longer.

12. Rambouillet ewes used in this study continued to increase in body weight through the fifth year of age. The average weight at that age for the sheared ewes was 114 pounds. After the sixth year there was a small but gradual decline in body weight.

13. The unscoured fleeces of the Rambouillet ewes that dropped lambs during a given year produced fleeces that averaged 0.57 pound per head less than fleeces produced by ewes that did not lamb during the year. The scoured fleeces produced by the fertile ewes averaged 0.27 pound per fleece below the production of the Rambouillet ewes that failed to lamb.

14. The shrinkage of 1944 fleeces produced by fertile ewes showed an average shrinkage of 60.03 per cent as compared with 59.52 per cent for fleeces produced by non-lambing ewes.

15. The length of staple produced by ewes that lambed during a given year averaged 0.08 inch less than that of the non-lambing ewes.

16. Diameter of fiber produced by the fertile ewes averaged slightly coarser than was produced by ewes that did not lamb during a given year.

17. Body weight differences between B and C type ewes of all ages was not significant.

18. Ewes that dropped lambs during any given year averaged 7.6 pounds less in body weight at shearing time than those that did not lamb.

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